Nonsurgical Treatment Outcomes and Prognostic Factors for Cases with Lesions of Endodontic Origin in a Private Practice

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Abstract

Aim: The prognosis of the healing of an apical lesion is extremely important for the treatment decision for tooth retention or implantation. In several studies, the presence of an apical lesion was shown to be a significant factor in both primary treatment and nonsurgical retreatment.

The aim of the present study was the retrospective investigation of the prognosis of the healing of bony apical lesions of teeth, which were treated endodontically. The evaluation contained various clinical parameters that can influence the success of the root canal treatment.

Materials and Method: 62 teeth were treated in 52 patients during the study period.

The treatment was carried out by a specialist in endodontics with the aid of the dental surgical microscope and a two-stage procedure. Two certified examiners assessed the radiological results after three to 72 months. Preoperative and postoperative information related to potential prognostic factors was evaluated.

Results: Results of the 62 apical lesions, 82.3% (examiner 1) - 88.75% (examiner 2) were classified as healed. Of all the prognostic factors analyzed, none showed a significant influence on the treatment success. The success rate of the present study was in the range of comparable studies.

Conclusion: The apical lesion can be treated with relatively high success rates if general micro-endodontic procedures are followed.

Keywords: Apical lesion; Endodontics; Tooth retention.
Introduction

The goal of any endodontic therapy is to prevent or hinder apical periodontitis [1].

A systematic review showed periapical radioluencies in 5% of the 300,861 teeth examined. Of the teeth examined, 28,881 were endodontically treated; 36% of these showed periapical radiolucencies [2]. Further epidemiological studies showed varying prevalence of apical periodontitis, depending on the patient’s age: between 20 and 30 years there was a prevalence of 33%, between 31 and 40 years it was 40%, between 41 and 50 years it was 48%, between 51 and 60 years it was 57% and over 61 years it was 62% [3]. Most studies in this area come from Europe and Scandinavia [4-6].

The primary reason for the development of a periapical lesion is an infection of the pulp tissue, caused by caries or other exogenous and endogenous factors [7-12]. Already in 1965, Kakehashi et al. showed that exposure of the pulp of normal rats to oral microorganisms leads to pulp necrosis and periradicular inflammation. In contrast, aseptic laboratory rats developed no pulp necrosis and periapical lesion [8].

Apical periodontitis is primarily an infectious disease; however, there are usually no bacteria in the periapical tissues, but only in the root canal [9,10]. A recurring apical lesion can also be triggered by bacteria remaining in dentinal tubules [11]. Exceptions to this can be apical periodontitis with abscess formation [12,13], Fistula ducts [3,14] or extraradicular infections [15,16].

A hypothesis for the development of apical periodontitis is its triggering by bacterial toxins, enzymes and harmful metabolic products [17]; this is possible because complete eradication of bacteria is not possible with the means and measures available so far [18]. In 90% of the infected root canals, a biofilm remains in the last 3 mm after endodontic therapy [18].

Ultimately, the development of a periapical infection is due to the virulence and number of bacteria and perhaps a certain germ composition in the periapical tissues [12-19].

A histological examination of human specimens showed apical paradontitis in 50 - 90% of the teeth treated endodontically [20].

The presence of an apical lesion is a significant prognostic factor both in primary treatment [21,22] as well as in nonsurgical retreatment [23,24]. X-ray examination is therefore an important tool for visualizing the periapical osseous lesion [25]. If there is an apical lesion, healing is less likely [26].

Aims/objectives

The success of endodontic treatment can be affected by several factors. An important point here is the preoperative presence of a bony lesion.

The work aims to investigate the prognosis of endodontic therapy in teeth with lesions of endodontic origin. In addition, the data should be determined and statistically calculated based on treatment documentation and follow-up examination, and the following hypotheses should be
checked in addition to the overall prognosis:

1. The success of the treatment does not depend on age.
2. The success of the treatment does not depend on gender.
3. The success of the treatment does not depend on the preoperative presence of a fistula.
4. The success of the treatment does not depend on the preoperative presence of pain.
5. The success of the treatment does not depend on the postendodontic care.

Materials and Method

Patients

All endodontic treatments were carried out independently on patients in his own practice or in practices where the treating dentist was employed. As with all of our endodontic treatments in practice, the exclusion criterion was later unpredictability of a prosthetic restoration of the tooth.

Radiological examination

Due to the referral structure of the cases, not all X-rays were taken with the same X-ray machine, but for reasons of radiation protection, the pre- and post-operative X-rays from the referring practices were also evaluated.

Clinical treatment

All endodontic measures were carried out according to the same protocol and under the dental surgical microscope.

After a sensitivity test, percussion test and palpation, an X-ray was taken or the alio loco image was assessed. The patients were informed about the treatment measures and, after their consent, the treatment was started in the same or the next session. Caries was removed if necessary. A dentineadhesive build up was done, if necessary. In all cases, rubber dam was applied. The canal orificia were located, and after their relocation, the length was determined endometrically, after obtaining “patency”. Subsequently, a glide path up to size .02/20 was manually established. With constant rinsing with 5.25 % NaOCl, the canals were mechanically expanded to the size specified by apical gauging, and the length was verified with an X-ray image. This was followed by a sound-activated rinsing sequence of 3 × 30 seconds with 5.25 % NaOCl and 1 × 30 seconds with 15 %EDTA and 5.25 % NaOCl. The session ended with the application of Ca (OH)$_2$ and the closure of the trepanation cavity, after securing the pulp cavity with a Teflon tape, with Cavit.

In the next session the Ca (OH)$_2$ was removed with 15 % EDTA after the application of a rubber dam. The working length determined in the previous session and any necessary adjustments were verified. This was followed by a sound-activated rinsing sequence of 3 × 30 seconds with 5.25%NaOCl, 1 × 30 seconds with 15%EDTA and 1 × 30 seconds with, depending on the filling material, 5.25 %NaOCl (with the obturation with gutta-percha and AHPlus) or 2 %CHX (for obturation with Resilon).

The three-dimensional obturation was performed randomly with resilon or gutta-percha in the "Continuous Wave
Technique" (downpack) and "Multi-Fill Technique" (backfill). The canal orificia were closed with a dentine adhesive build up and the patient was discharged after being informed about the need for further tooth care. Patients were also informed of the need for radiographic and clinical follow-up at half, one, two and four years intervals, which was performed at the referring dentist or in our practice.

Radiological evaluation

An attempt was made to assess the periapical lesion based on periapical x-rays. Due to the referral structure in practice, and for reasons of radiation protection, orthopantomograms were also evaluated and periapical x-rays were not additionally taken.

The “periapical index score” was used for the evaluation according to Orstavik et al. [27]. The index consists of five numbered categories (Figure 1). Each root was categorized:

1. Normal periapical structures
2. Small changes in the bone structure
3. Changes in bone structure with some mineral loss
4. Periodontitis with a well-defined radiolucent area
5. Severe periodontitis with signs of exacerbation.

Figure 1: Examples of PAI scores assigned to radiographs from the cohort of this study according to Orstavik et al.
a sign of periapical pathology [27]. Apical periodontitis, including periapical cysts and periapical granulomas, were defined by a PAI score of 3, 4 or 5 [34].

**Statistical analysis**

In the context of this study, various criteria, and their possible influence on the success of the endodontic therapy performed, were examined. For this purpose, the data was evaluated using the Mann-Whitney test and the chi-square test at the 5% significance level.

This method is a common procedure. Furthermore, the correlation of the evaluation results of the two examiners was checked by means of the gamma value.

**Results**

**General characteristics of the whole collective**

**Age of patients in the total population**

Patients were 47.08 years old on average at the time of canal obturation and the standard deviation was ± 12.70 years. The youngest patient was 24 years old, and the oldest patient was 70 years old, when the root canal was filled.

**Gender distribution of the whole collective**

In the total collective, there were just as many men n = 31 as women n = 31.

**General preoperative factors**

**Preoperative presence of a fistula:** A total of 23 patients had a fistula preoperatively; in 39 patients, a fistula could not documented.

**Preoperative pain**

A total of 54 patients with pain and 8 without treatment for root canal treatment were presented.

**General post-operative factors**

**Postendodontic care**

After the endodontic therapy, 49 patients with a crown restoration, 12 patients with a composite restoration and one patient with an amalgam restoration were presented.

**Radiological features**

**Initial radiological situation**

Both examiners showed a high degree of correlation in the radiological assessment of the initial situation γ = 0.984. At the start of treatment, the examiners diagnosed in 10 and 9 cases a PAI score of 3, in 33 and 38 cases PAI score of 4, and in 19 and 15 cases a PAI score of 5.

**Final radiological situation**

Both examiners showed a high degree of correlation in the radiological assessment of the initial situation γ = 0.984. At the recall appointment, the examiners diagnosed a PAI score of 1 in 40 or 42 cases, in 11 or 13 cases a PAI score of 2, in 6 or 3 cases a PAI score 3, in 4 or 3 cases a PAI score 4, and in 3 or 5 cases a PAI score 5.

**Influence of various factors on the success of treatment**

In the following, the various factors are evaluated and presented with regard to their importance for the success of treatment. Both preoperative and postoperative factors were examined.
Effects of Age

In the present study, patient age had no influence on the success of therapy and the differences between the groups were checked using the Mann-Whitney test. The average age of the patients who were cured was 46 years. The average age of the patients who could not be cured was 48.4 years.

Effect of gender

Examiner 1 with a p-value = 0.319 as well as for examiner 2 with a p-value = 0.229, the gender of the patients showed no significant influence on the treatment outcome.

Influence of the presence of a preoperative fistula

Examiner 1 with a p-value = 0.956 as well as for examiner 2 with a p-value = 0.738, the presence of a preoperative fistula of the patients showed no significant influence on the treatment result.

Influence of preoperative pain

In both examiners, preoperative pain had no significant influence on the treatment outcome. (p-value = 0.355 or 0.674).

Influence of postendodontic care

For examiner 1 with a p-value = 0.068, post-endodontic treatment had no influence on the treatment outcome. For examiner 2, despite a p-value = 0.018, no significant influence on the treatment result could be shown due to an insufficient amount of data.

Overall prognosis

The overall prognosis for healing of lesions of endodontic origin showed in the present study (n = 51) has a probability of 82.3% (n = 51) and 88.7% (n = 55). Figure 2 (a and b) shows some examples of healing patterns observed in the study.

Figure 2: a and b shows some examples of healing patterns observed in the study.
Discussion

The long-term prognosis of endodontically treated teeth is important for the decision between tooth preservation or extraction. An assessment appears difficult due to various factors besides the periodontal situation [35]. This is contradicted by a study that showed both a lower probability of success in the presence of an apical lesion and again a significantly lower probability of success in the case of larger lesions [36].

However, it was also shown that complete disinfection is very difficult or just as impossible as complete removal of pulpal debris [37-39]. “Patency” was used as part of the preparation, which means that the foramen was cleaned of debris [40] without being enlarged or shifted in position [41]. This leads to better cleaning of the apical third [42]. It was shown that the intraoperative presence of “patency” resulted in significantly less tooth loss within the first 22 months after the therapy [43].

The crucial role of biofilm in the development of apical periodontitis is becoming increasingly clear [44,45]. The ability of bacteria to organize themselves in the biofilm is therefore of great importance. Planktonic bacteria in the root canal can be easily reached and eliminated with chemo-mechanical cleaning, but the biofilm cannot [46]. Apical ramifications, lateral channels and isthmi contain bacteria that are often organized in biofilm-like structures [18,47,48].

In one study, depending on the radiological size (small/large) of the lesion, a biofilm was found in 62% and 82% of the cases. An extraradicular biofilm, that is also considered a possible cause of posttherapeutic apical periodontitis [49,50], could only be demonstrated in 6% of the cases [46].

Other extradadicular causes can be non-bacterial endogenous or exogenous factors [51]; these include cholesterol crystals and foreign body reactions to endodontic filling material [52,53].

Bacterial persistence in the root canal is the main cause of persistent apical periodontitis, but this does not always lead to a lack of healing. Some lesions heal even if the bacterial test is positive before the canal system is obturated [54,55]. Possible explanations are the death of the remaining bacteria (antimicrobial activity of the filling material, lack of food or interruption of bacterial interaction), a subcritical number for the maintenance of the inflammation or a localization without access to the periradicular tissues [56].

The microbiological goals of the endodontic treatment are the reduction of the bacterial colonization to an amount possible for parapical healing and the prevention of bacterial recolonization of the treated tooth. This is attempted through antimicrobial measures (chemomechanical cleaning/intracanal medication) and obturation [57]. Numerous studies show that canal systems that did not contain any cultivable bacteria before the obturation show better therapy results [54,58,59].

This is why there was a desire for a clinical protocol that predictably leads to negative cultures [56], also when understanding the limitation of cultures [60].
There are controversial opinions on the treatment protocol, regarding single-visits versus multiple-visits [61]. The chemomechanical preparation of the canal system with NaOCl (0.5 - 5%) still shows cultivable bacteria that can be found in 40% - 60% of the cases [62-64]. Since residual bacteria can have a negative impact on the success of the treatment [54,55] an intracanal medication is recommended in addition to chemo-mechanical cleaning to increase bacterial reduction [65-69].

Calcium hydroxide is the most commonly used intracanal medication; however, a significant improvement in root canals that could be negatively cultivated could not be shown consistently [65,66,70]. An intermediate application of Ca(OH)$_2$ in the sense of a two-stage therapy showed lower bacterial contamination, a lower expression of matrix metalloproteases and a better organized extracellular matrix. The studies conclude that a two-stage approach with the intermediate storage of Ca(OH)$_2$ could positively influence the periapical healing process [32,71].

The anatomical complexity and the presence of a biofilm would allow an efficient reduction of the bacterial load and thus a particularly favorable long-term prognosis with the currently usual preparation methods and chemical solutions [18]. Likewise, a more favorable healing process could be shown in animal experiments with a two-stage procedure [72].

No difference in the healing process could be shown in other studies [31,59,73,74], which gives rise to the desire for more disinfectant medications than the currently available [70]. The ideal result of endodontic treatment of periradicular diseases is the repair or regeneration of the diseased tissue. The goal is to restore the original structure and function of the diseased tissue. However, complete regeneration is only possible in the prenatal fetus. Postnatal wounds therefore always heal only through a combination of repair and regeneration [75].

A promising future path could be the insertion of stem cells into the apical defect [76].

A possible connection between chronic oral inflammatory processes, such as apical periodontitis or periodontal diseases, and general diseases is also a frequently discussed question in physics and dentistry. Segura-Egea et al., based on the current state of knowledge, believe that diabetes is associated with a higher prevalence of periapical and larger osteolytic lesions, a higher probability of asymptomatic infections and a poorer prognosis for endodontically treated teeth [77].

Periapical diseases also appear to play a role in diabetic metabolic dyscontrol [43,77].

Another animal study showed no association between the presence of apical periodontitis and an increased nonspecific inflammatory marker in the blood [78]. It also seems possible that a genetic disposition, combined with an increased IL-1β, leads to a greater susceptibility to apical periodontitis [79].

In the present work, the prognosis of endodontic therapy, in the presence of a preoperative apical lesion, was examined. The Toronto study showed a healing...
forecast of 82% [80] and 80% for nonsurgical retreatment of teeth with apical radiolucency [24]. In practice, 82.3-88.7% of the teeth were healed radiologically and are therefore within the range given in the literature.

The prognosis of endodontic therapy depends on the ability of the dentist to manage anatomical problems. Complete chemo-mechanical cleaning and complete filling of the canal system leads to successful therapy on every periodontally healthy or at least periodontally treatable tooth [81].

Ng et al. also found eleven prognostic factors that influence periapical health after primary and revision treatments: the presence of a periapical lesion, the size of an apical lesion, the absence of a fistula, the achievement of "patency" on the foramen, the length of the canal preparation, the use of an EDTA rinsing solution followed by a NaOCl solution, avoidance of a 2 % Chlorhexidine solution in connection with NaOCl, the lack of a tooth or root perforation, the lack of flare-ups between treatment appointments [82].

The age of the patients was not decisive for the success of the therapy in the present study. This result has been confirmed in some studies [21-24]. However, one study showed significantly better healing of apical periodontitis in the age group of 50-59 years [83].

The success of therapy was not gender-dependent in the present study and also showed no significant influence in other studies [21,53]. One study showed significantly better healing in women than in men [22]. An animal study found a possible explanation when examining the relationship between estrogen and systemic response to induced apical periodontitis. Female rats suffering from an estrogen deficiency showed a significantly more pronounced systemic reaction than male test animals. They concluded that female test animals with a normal estrogen level are better protected against systemic reactions than male ones [84].

An indication of the influence of a fistula or pain on the success of treatment could not be proven in the present study. Ng et al. showed however a crucial influence of preoperative pain [43] and the presence of a preoperative fistula [82].

Coronal leakage is a major cause of post-endodontic disease [51,85]. Various studies showed the development within three to ninety days [86-88]. An adequate coronal restoration should therefore be prepared as soon as possible [85,88,89]. In the present study, all teeth were adhesively sealed immediately after the three-dimensional obturation, as an independent step in the treatment process [90,91]. The further postendodontic restorative measures showed no significant influence on the treatment result.

The Periapical index score is a highly reliable scoring system [92]. The periapical index was first described for periapical X-rays [27,93-96]. However, in some studies, panoramic shots were also made [97-100] or a combination of panoramic images and periapical X-rays [4,101,102].

Some studies have underestimated the presence of lesions when using panoramic images [4]. One study showed better detection using panoramic images [103], others showed similar results [104-106].
A high percentage of teeth that were perceived to be healed based on periapical X-ray images often showed an enlarged lesion in a study at the CBCT. The reliability of the PAI at all tooth positions could be questionable due to the thickness of the cortical bone and the position of the root tip [107].

This inadequacy can be avoided in the future by using the new "cone beam computed tomography periapical index" (CBCTPAI), an accurate diagnostic method that minimizes the incidence of false negative diagnoses and investigator interference, and thus the reliability of studies on prevalence and severity periradicular periodontitis increased [108].

References

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